INTERMOUNTAIN STATION
Central Reference File
No. 0,73

APPALACHIAN FOREST EXPERIMENT STATION

PERSONNEL, 1928

E. H. Frothingham		Director
C. F. Korstian		Senior Silviculturist
C. R. Hursh		Associate Forest Ecologist
F. W. Haasis	(Resigned, Aug. 29, 1928)	Assistant Silviculturist
J. H. Buell		Assistant Silviculturist
I. H. Sims		Junior Forester
A. L. Mackinney		Junior Forester
C. A. Abell		Junior Forester
A. B. Hatch	(June to September, 1928)	Junior Range Examiner
Josephine Laxton		Senior Clerk
Elisa M. Pearson		Clerk

BUREAU OF ENTOMOLOGY

J. A. Beal — Assistant Entomologist

BUREAU OF PLANT INDUSTRY

R. M. Nelson — Assistant Pathologist

BIOLOGICAL SURVEY

A. H. Howell (Six weeks) — Senior Biologist

TEMPORARY ASSISTANTS, 1928

Forestry

A. H. Beal	Mass.	Orville Lester	Ia.
A. T. Blidberg	Sweden	H. F. Morey	Ia.
D. E. Bradshaw	N. C.	H. C. Moser	Ia.
W. C. Bramble	Pa.	W. L. Nothstein	Pa.
J. C. Craig	Mich.	H. F. Scholz	Ia.
R. B. Craig	Mass.	R. E. Wilson	N. Y.
A. D. Follweiler	Pa.	R. M. Ziegler	Pa.
William Hallin	Minn.		

Entomology

A. H. Beal	Mass.	H. K. Rippey	Ind.

Pathology

Dale Chapman	Minn.	Frank Kaufert	Minn.

APPALACHIAN FOREST RESEARCH COUNCIL

MEMBERSHIP IN 1928

W. D. Tyler — President

J. H. Pratt, Chairman of Executive Committee

Kentucky

T. P. Cooper, Director, Kentucky Agr. Experiment Station, Lexington.
W. J. Hutchins, President, Berea College, Berea.

North Carolina

G. A. Cardwell, Atlantic Coast Line Railway, Wilmington.
Andrew Gennett, President, Gennett Lumber Co., Asheville.
J. S. Holmes, State Forester, Raleigh.
J. H. Pratt, Consulting Engineer, Chapel Hill.
Verne Rhoades, Consulting Forester, Asheville.
R. B. Robertson, President, Champion Fibre Company, Canton.

South Carolina

H. L. Tilghman, Tilghman Lumber Company, Marion.

Tennessee

S. F. Horn, Editor, Southern Lumberman, Nashville.
R. S. Maddox, State Forester, Nashville.

Virginia

P. R. Camp, Camp Manufacturing Co., Franklin.
J. P. Hummel, Hummel-Ross Fibre Corporation, Hopewell.
Chapin Jones, State Forester, Charlottesville.
W. D. Tyler, Clinchfield Coal Company, Dante.
George L. Wood, R. E. Wood Lumber Company, Hotchkiss.

West Virginia

A. B. Brooks, Waddington Farm, Wheeling.
T. H. Clagett, Chief Engineer, Pocahontas Coal & Coke Co., Bluefield.
George D. Curtin, Pardee & Curtin Lumber Company, Clarksburg.
John Raine, Meadow River Lumber Co., Rainelle.

C O N T E N T S

Page

Station activities in 1928 1

Territory and functions of the Appalachian Station 1

Administration 2

Allotment and expenditures 2

Personnel changes 3

Quarters 3

Branch stations 3

Cooperative agencies 5

Appalachian Forest Research Council 5

Visitors during 1928 5

Progress of investigations in 1928 7

Management 7

Tree studies 12

Forest fire studies 13

Forestation 14

Forest insect investigations 14

Studies in forest pathology 16

Biological investigations 16

Weather 17

Forests, streamflow, and erosion 17

Summary of projects completed in 1928 18

Plans for 1929 19

Management 19

Forest fire studies 20

Mensuration 20
Forestation 21
Forest insect investigations 21
Forest pathology 22
Biological investigations 22
Weather 22
Botanical studies 22
All-Service projects 23
Branch Station activities planned 23
Important subjects for future investigation 24
Current projects in order of importance 26
List of permanent sample plots 27
Articles prepared or published, 1928 33
Articles to be prepared in 1929 35

INVESTIGATIVE REPORT FOR 1928 AND PROGRAM FOR 1929.

APPALACHIAN FOREST EXPERIMENT STATION

ASHEVILLE, N. C.

STATION ACTIVITIES IN 1928.

The seventh investigative report of the Station, issued in 1928, summarized the work on all projects since the Station's establishment, in 1921. The present report will review only the additional progress made during the past year and will outline the work recommended for the field season of 1929.

Territory and Functions of the Appalachian Station

The territory of the Appalachian Station embraces the States of Virginia, West Virginia, North and South Carolina, eastern Kentucky and Tennessee, and northern Georgia and Alabama -- an aggregate of about 120,000,000 acres, of which about 76,000,000 acres are forest land. The Appalachian Mountain system -- Blue Ridge, Smoky Mountains, and cross ranges -- forms the backbone of the region. West of it and separated from it by the great Appalachian Valley, are the Alleghany and Cumberland highlands of West Virginia, Kentucky, and Tennessee. East of the Blue Ridge is the Piedmont Plateau, and still farther east is the Coastal Plain. From the standpoint of timberland management and forest investigations the forests fall into two classes: extensive tracts and small farm woods. Most of the former are in the mountains and on the Coastal Plain, while most of the latter are in the plateau and valley regions.

The productive management of these forests, whether publicly or privately owned, is of great importance to the region as a means of utilizing otherwise waste lands for local supplies of forest products and the maintenance of wood-using industries. Other important functions of the forest, that can be fully attained only under proper forest management, are to prevent erosion and the sitting up of storage reservoirs, increase the regularity of streamflow, serve as a protection for game and fish, and as a place for regulated hunting, fishing, and other recreation. The special management of forests for timber production and the other uses accordingly rests upon a knowledge of timber growth and reproduction, methods of forest protection, the relation of forest cover to precipitation and run-off, the life habits of forest animals, and all other factors that affect the proper utilization of forest resources to ensure their perpetuation.

It is the function of the Appalachian Station to acquire the information on all these subjects that is needed for good forest management. This is attempted through the experiments and investigations that were reviewed in detail in last year's report and are the subject of the present paper. This work is carried on primarily at several branch stations, at which the best methods of forest management and protection will be demonstrated. As yet the funds available to the station are not sufficient to undertake work on all the important subjects. For example, practically nothing can be done on the subject of the relation of different types and conditions

of forest to erosion and stream flow without seriously interfering with the studies already under way. The same is true for the much needed study of cut-over areas as a basis for determining the broad economic management of these extensive and at present poorly productive mountain and coastal areas.

Administration

Allotments and expenditures

During its first five years the Station's annual allotments were between $17,000 and $21,000. It soon became apparent that these allotments were wholly inadequate for the large volume of work to be done, and in 1926 an increase of $18,000 was made available by Congress. This brought the allotments for the fiscal years 1927 and 1928 to $37,450. This allotment does not provide for work in forest entomology and forest pathology which is financed from the appropriations to the Bureaus of Entomology and Plant Industry, U. S. Department of Agriculture.

The following tabulation shows the various lines of investigation for which the funds allotted to the Appalachian Station were expended:

Expenditures for investigations in 1928 and preceding fiscal years

Activity	Fiscal year 1928 Amount	per cent	1927 Amount	per cent	1922-6(Aug.) Amount	per cent
Management	22,227.07	60	13,698.00	37	7,030.40	37
Protection	3,862.47	10	2,637.00	7	3,679.20	20
Tree studies	3,446.34	9	10,091.00	27	4,459.20	24
Forestation	1,491.27	4	2,952.00	8	2,141.40	11
Measurements	80.85	-	436.00	1	----	---
Miscellaneous*	6,389.98	17	7,351.72	20	1,541.62	8
Total	37,497.98	100	37,165.72	100	18,851.82	100

*Includes special work not carried on Station Program; particularly, in 1928 some preliminary studies of forest litter, the silt load of streams, investigation of branch station possibilities, preparation of addresses and papers for publicatiom, etc.

Forest investigative work is especially complicated in the Southern Appalachian region by the wide extremes of forest conditions, involving a great number of problems. A tentative schedule of needed work that was prepared in 1927 contains enough important projects to occupy a much larger staff of specialists than the present one. As previously stated, the Station's allotment is not yet sufficient to provide for some lines of work that ought already to be under way. One of the most important of these is a thorough-going study of the relation of forests to stream-flow and erosion. It is believed that the funds and personnel needed for this work should be provided as quickly as possible

Personnel Changes

The staff was increased during the year by the appointment of C. A. Abell as junior forester. Two members of the staff, Assistant Silviculturist F. W. Haasis and Junior Forester I. H. Sims, were on educational furlough during a part of the year. Haasis received the Ph. D. degree in plant physiology at Johns Hopkins University in June, 1928. Sims got his master's degree in forestry at the University of Michigan and returned to the same institution in September for additional postgraduate study. Although the Station was thus deprived of two of its permanent staff for a large part of the year it had the benefit of the services of Junior Range Examiner A. B. Hatch during the summer. Hatch left in September to study for a master's degree at the Yale School of Forestry. The staff was further depleted by the resignation of Dr. Haasis to accept the position of associate professor of forestry at the University of Idaho.

This reduction of the Station's permanent staff made it possible to employ a somewhat larger number of temporary assistants than usual. Four of these men left the Station to accept permanent positions. H. F. Scholz was appointed Junior Forester at the Lake States Forest Experiment Station. A. D Follweiler and W. L. Nothstein became District Foresters in the Forestry Division, North Carolina Department of Conservation and Development. R. B. Craig became forester to an estate owning a 13,000 acre tract of timber land in the vicinity of Louisville, Ky.

Quarters

Station headquarters were moved in June to the sixth floor of the new Asheville City Hall, where eight rooms have been leased. These rooms are much larger than the six previously occupied in the Medical Building, giving a floor space about four times as large as that of the old quarters. On the same floor are the offices of the Pisgah National Forest, the district forester of the North Carolina State Forest Service, the North Carolina Park Commission, and the Geological Survey. This concentration of forestry and related activities is very advantageius.

Still another change of quarters is in prospect. This will probably be within the next two years to the new Asheville Federal Building, work on which will probably be begun in June or July, 1929. Very satisfactory quarters have been provided for the Station.

Branch Stations

The policy of concentrating the work at relatively few points in the region has been adopted as a means of reducing costs, increasing efficiency, and providing demonstrations of investigative results. Thoroughly satisfactory working centers are hard to find. Only three branch stations have been definitely selected and approved. These embrace respectively the territories around Asheville, including the Bent Creek experimental forest; Berea, Kentucky, so far confined to the Berea College forest; and Edinburg, Virginia, on the Shenandoah National Forest. The recommendation for a branch at Marlinton, W. Virginia has not yet been approved, because of doubt as to whether Marlinton is the best point for headquarters. In Kentucky, the

the proposal to include the Robinson sub-station forest, near Quicksand, Kentucky, with Berea in a single branch station, was approved, and work is to be done there during the coming season. No branch station has yet been definitely recommended for the Coastal Plain, although several places are being considered.

Since it is not desirable to start continuing work at other points than branch stations, the small number of these is a decided handicap. Consequently during the past season all of the Station's field parties were requested to report on locations visited that appear of promise for branch stations, the requirements for which were stated in last year's report. In addition, several special trips were made and reports prepared on possible locations. Among these were the Arcadia Working Circle and Arnold's Valley tracts of the Natural Bridge National Forest, the Wayah Creek district of the Nantahala National Forest, and several places in the Coastal Plain of North and South Carolina and Virginia.

One of these, the Lee National Forest, near Petersburg, Virginia, which had been rather definitely decided upon, had to be given up, due to the abandonment of the land as a national forest and its sale for real estate purposes. Others in the Coastal Plain proved unsatisfactory for various reasons and were given adverse reports. A very promising prospect on the lands of Duke University was visited twice. It is probable that recommendations for its approval will be forthcoming, subject to satisfactory arrangements with the University. E. N. Munns, Chief of the office of forest experiment stations of the Forest Service visited West Virginia and Kentucky in company with Frothingham to inspect the branch station possibilities there.

Berea - Quicksand The part of the forest tract on the lands of the Robinson sub-station of the Kentucky Agricultural Station that was visited by Munns and Frothingham lies about 18 miles from Quicksand. The forest tract, of about 15,000 acres was presented to the State several years ago, after being logged, for experimental and demonstration purposes. The tract is being cruised and mapped by the Agricultural Station's forester, Mr. C. H. Burrage, who has also started some weeding experiments in hardwood reproduction and planting tests of a number of coniferous species. At the points visited on this tract excellent hardwood reproduction was observed on all but the dry, rocky sites. The principal handicap seemed to be a large amount of timber, largely beech, left standing as unmerchantable. A problem of exploitating this timber is suggested, since it will interfere with the development and value of the second-growth stand. A road now under construction through Breathitt County will penetrate the tract and will doubtless open up a market for some of this material for mine props and other purposes. This road also will make the tract more accessible to the field parties from the Appalachian Station.

At the request of Mr. Burrage, suggestions for a preliminary plan of work on these lands were drawn up by Munns and Frothingham and forwarded to Director T. P. Cooper of the Kentucky Agricultural Experiment Station.

At Berea, tentative plans were made with President Hutchins, of Berea College, for the mapping ad sub-division of the College forest as an experimental and demonstration forest. A large map showing boundaries and roads was furnished by the College, and this was photographed down and a number of reduced scale prints made.

Berea was revisited in August by Frothingham in company with R. D. Garver, of the Forest Products Laboratory. The purpose of the visit was to suggest means of increasing and improving the utilization of wood from the College forest, as a part of the proposed plan for management as a demonstration forest. A report was subsequently furnished by Mr. Garver.

The investigative work done at Berea in 1928 is described under the headings "Management: Methods of Cutting."

Bent Creek Experimental Forest The tentative location of compartment lines for the sub-division of the Bent Creek forest was decided upon with the aid of a topographic map of the area, and tentative compass lines were marked out in the field. These were later inspected and revised, and the work of running permanent lines by transit was started. These lines, which are being brushed out to a width of six or eight feet, will divide the area into 21 compartments with an average area of about 50 acres. The compartments will then be further sub-divided into sub-compartments based upon differences in forest composition; and each compartment will be carefully cruised and described as to composition, condition, amount, and age of timber, character of undergrowth, reproduction, etc. From these descriptions the plan of management will be prepared. It is hoped that this preliminary work will be finished during the coming spring.

Cooperative Agencies

Of greatest interest is the appointment by the State of South Carolina of a State forester, Mr. Lewis E. Staley, formerly of the Pennsylvania State Forest Service. Every State wholly or partly in the Station's territory now has a forestry agency. All these agencies were very helpful to the Station during the year. Among the private cooperators, particular mention should be made of the Cranberry Iron and Coal Company, through whose representative at Cranberry, N. C., Mr. L. D. Ellis, the Station was enabled to begin the thinning studies in yellow poplar described under the heading "Management"; the Champion Fibre Company, at Canton, N. C., for use of seed beds in its nursery, for raising experimental planting stock; the Carolina Fibre Company, for the use of its lands at Lane's, S. C., for controlled burning experiments; and the Biltmore Estate Company for facilities rendered in connection with the thinning experiments on the Estate. A number of other companies and individuals rendered useful advice and assistance to the Station.

Appalachian Forest Research Council

In conformity with the rotating policy of Council membership, three new appointments have been made by the Secretary of Agriculture. These are Mr. George D. Curtin, of the Pardee and Curtin Lumber Company, Clarksburg, W. Va.; Mr. J. P. Hummel, President, Hummel-Ross Fibre Corporation, Hopewell, Va.; and Mr. H. L. Tilghman, of the Tilghman Lumber Company, Marion, S. C.

Visitors during 1928

Forstassessor H. F. von Maltzahn, of the Mecklenburg State Forest Service in Germany, spent about a week at the Station, making trips to the Smoky Mountains, Pis-

gah National Forest, Biltmore Estate and the Bent Creek experimental forest.

J. M. Miller and J. C. Evenden of the Division of Forest Insects, Bureau of Entomology, came by en route from Washington to the West. Mr. Miller is in charge of the entomological field Station at Palo Alto, California, and Mr. Evenden the Coeur d'Alene, Idaho, station.

Dr. and Mrs. Unio Saalas, of Finland, spent a week visiting the entomological activities of the Station with Beal. Dr. Saalas is professor of agriculture and forest zoology at Helsingfors.

Dr. and Mrs. Tragardh of Stockholm, Sweden, spent several days in Asheville. Dr. Tragardh was much interested in studying soil fauna at the Bent Creek laboratory.

Dr Dufenroy, Director of the plant pathological Station at Brive near Paris, France, was another interesting visitor.

Arthur Koehler, in charge of the Section of Wood Technology, Forest Products Laboratory, spent a day or two in Asheville, discussing closer coordination between the Laboratory's studies in wood technology and the work of the Station.

A. B. Trist of Brisbane, Australia, spent some time with our field parties previous to his year of residence at the Yale Forest School.

Among the members of the Forest Service who visited us were O. A. Zimmerli, of the Office of Finance and Accounts, G. A. Pearson, Director of the Southwestern Forest Experiment Station, and Major Kelley, R. M. Evans and Louis King of District 7.

Other visitors were W. L. Hall of Hot Springs, Ark., Arthur M. Miller, former State Geologist of Kentucky, and F. W. Reed of Washington.

PROGRESS OF INVESTIGATIONS IN 1928

Management

Silvicultural and Protective Requirements

The manuscript of "Timber Growing and Logging Practice in the Southern Appalachian Region" was completed and submitted for publication. This bulletin covers the mountain and plateau portions of the Station's territory, and is one of a series pertaining to all the forest regions of the United States. The coastal plain portion of the Station's territory is treated in the bulletin of this series for the southern pine region.

The bulletin on the Southern Appalachian region was prepared very largely from results obtained in the Station's regular investigative projects. In particular, the results of the last two years' study of cut-over areas afforded specific information on forest conditions that was not available previously. Some of the last remeasurements of permanent sample plots were also very useful. On the other hand, the work revealed an unfortunate lack of information in several important respects. For example, nothing definite could be given as to the extent of the different classes of forest land. Forest land areas had largely to be derived by inference from census statistics. Forest fire statistics are not fully satisfactory. The need of more wide-spread and thorough-going investigations as a basis for silvicultural practice was strongly evident, in view of the great variety of forest types and conditions to be encountered in the region. The bulletin gives recommendations for the treatment of forest lands to keep them productive and to raise full crops of timber. These had to be given in rather general terms because the investigations of the Station have not advanced far enough to afford more specific information.

Methods of Cutting and Natural Reproduction in the Hardwood Types

Of the three phases discussed in last year's report-- extensive survey, permanent sample plots and intensive studies-- progress was made in the first two. In the extensive survey, forty-two half-acre plots were run in a twelve-year-old unburned cutting on the Nantahala National Forest. In 1927, 263 plots averaging a half-acre each, were measured on the Unaka and Natural Bridge National Forest. The results have been compiled and classified according to forest type and site, and degree of severity of cutting. Preliminary tabular statements of these records are contained in the manuscript for the bulletin "Timber Growing and Logging Practice in the Southern Appalachian Region". A general discussion of the work, prepared by J. H. Buell, appeared in the Southern Lumberman for Dec. 22, 1928. From the records so far taken it is apparent that Southern Appalachian hardwood cut-over areas are badly understocked with good trees of desirable species, and that inferior and defective trees are prejudicing the development of valuable second-growth stands.

A change was made in the technique of estimating the amount and kind of small reproduction one-half inch and less in diameter breasthigh, that was used in the extensive survey in 1927. Instead of tallying all such reproduction on a single

milacre (an area ten links square) at the end of each five chains of strip, a tally was made of the stocked condition of all milacres along the chain. This tally showed for each milacre (1) whether the milacre was shaded or "free" (open to light); (2) for each "free" milacre the species and height of the tallest dominant tree stem, if any; (3) the origin (seedling or sprout) of this stem; (4) the nature of the shade (tree or brush); and (5) the condition of the slash, if any was present. The milacre-strip tally was in conjunction with a tally of the trees three inches and over in diameter on a chain-wide strip, and a tally of the smaller diameters on a narrower strip.

Considerable difficulty was experienced in analyzing these data, because of the large number of variables of composition, site, period since cutting and stand condition. The number of these variables was reduced by combination to 52, for the 305 plots measured. For the purposes of the bulletin on "Timber Growing and Logging Practice" the number of variables was still further reduced by larger combinations.

The work on permanent sample plots in the methods of cutting study included the establishment of a one-acre plot at Stony Fork, Pisgah National Forest, and two half-acre plots on the Bent Creek experimental forest; and the remeasurement of the four plots at Berea, Ky., and the four at Lookingglass Rock, Pisgah National Forest.

On the Berea plots only the larger trees and accessions were remeasured, the interior quadrats having been measured in 1927. The minimum diameter for the larger trees and accessions was reduced from 3 inches to 42 inches, breast high. One of the plots (No. 4) was divided into three parts to conform to stand differences, and quadrats were established in the control plots. For the treated plots a tree location map is advocated. The reproduction on these plots has grown so rapidly that opportunities are now presented for experiments in cleaning and disengagement cutting. These could be carried on to advantage on small interior plots, with controls.

The four half-acre sample plots at Lookingglass Rock are in a 12 year old stand, largely of sumac, chestnut, and silverbell with an understory of yellow poplar, that came in after a severe fire in 1916. The plots were established in 1923-24, at which time two of them were given a release cutting to favor the shaded yellow poplar. The other two plots were left intact as controls. Within the larger plots interior reproduction plots were laid out in which the height of each seedling and sprout was recorded by serial number. In 1928 the large plots were completely remeasured for the first time, while the numbered seedlings in the small reproduction plots were given their third measurement. Tagging and descriptive records of all trees in the 2-inch class and above were started. It appears that the crown cover of the stand has more than doubled in height. A comparison of the yellow poplar in the released and control plots is of interest:

Yellow poplar reproduction in treated and control plots

Size	Treated Plots				Untreated control plots			
	No. per acre		Avg. height, ft.		No. per acre		Av. height. ft.	
	1924	1928	1924	1928				
.5 in. and less,d.b.h.	6120	3960	2.80	7.36	2760	1640	1.74	3.45
More than .5 in.d.b.h.	216	3767	-	-	148	994	-	-

The difference in the height growth of the smaller yellow poplars, following the release cutting, is noteworthy. A small part of one of the treated plots in which black locust is dominant was marked out as a sub-plot for separate observation of the behavior of yellow poplar reproduction under locust cover.

Natural Reproduction on Cut-over Spruce-fir Lands

The final report on this project is being completed for publication.

Thinnings

The sample plots established in the Biltmore Estate, in 1916, for the study of effects of thinning in planted stands, were given their third measurement in October, 1928. They are to be thinned before growth starts in the spring. Summary tables for the thinned and control plots in the white pine plantations, showing volume and number of trees per acre at the time of each measurement, were prepared for publication in the circular "Forest Plantations at Biltmore, North Carolina". In one set of plots (in the "Old Orchard" white pine plantation) the difference in growth rate between the thinned and control plots is very marked. In the thinned plot the annual growth between the first two thinning, fall, 1916, and spring, 1923, was at the rate of 115 cubic feet per acre, while in the six years following the second thinning it amounted to 135 cubic feet. In the two control plots, combined, the annual growth for the corresponding periods was at the rate of only 82 and 23 cubic feet per acre, respectively. In the thinned plot, also, there was removed in the two thinnings a useful volume of wood equivalent to 1640 cubic feet per acre: in the control plots, of course, this wood that might have been salvaged by thinning was a total loss. The thinned plot, with 504 trees per acre in 1928, is in a much better condition for growth than the unthinned, overdense control plots, with 872 and 1696 trees per acre, respectively.

In another set of white pine plots at Biltmore (in the "Apiary" plantation) the annual growth rate between the first two thinnings (123 cubic feet per acre) was about double that for the corresponding period in the unthinned plot (63 cubic feet per acre); but for the six years following the second thinning the growth rate of the thinned and unthinned plots was about equal (150 cubic feet per acre and year, in round numbers). Evidently the second thinning was considerebly too heavy and left the stand too thinly stocked for efficient production. The growth of the unthinned stand, however, was distributed among a large number of small trees at the rate of 725 to the acre; while that of the thinned stand was concentrated on carefully selected, thrifty trees at the rate of 336 to the acre.

The Station has taken over a pair of sample plots, thinned and control, established in 1920 by State Forester J. S. Holmes in second-growth yellow poplar on the lands of the Cranberry Iron and Coal Company. These plots were remeasured by the Station in 1922 and again in 1928. The extent and uniformity of this yellow poplar stand, now about 40 to 45 years old, suggested the desirability of additional plots, and five were laid out and the trees tallied by diameter and crown class. These tallies have been compiled as a partial guide for determining the thinning methods to be used on the plots in the spring of 1929.

Work on the loblolly pine thinning project is being deferred until a definite program for the Coastal Plain investigations has been prepared, as a result of the survey now in progress.

Appalachian Logging and Milling Study

A study of hardwood logging and lumber manufacture at small saw-mills in the Appalachian mountain region was made in 1928 by a party from the Forest Products Laboratory, in cooperation with the district office of the Forest Service, the Appalachian Forest Experiment Station, the office of Forest Pathology, and the division of forest insect investigations, of the Department of Agriculture. This study was for the purpose of collecting data on grades of lumber manufactured, defects, overrun, production costs, and the amount of waste in the woods and mill. It also covered other problems, such as an intensive study of defect, from both the pathological and the entomological aspects, improvement of small mill practice, characteristic defects in different species, seasoning methods, little used species, etc. The work was done on and near the Pisgah and Shenandoah National Forests. Out of the many species in the Appalachian region, the following were selected for special study: chestnut oak, white oak, scarlet oak, northern and southern red oaks, black oak, chestnut and yellow poplar. The work was badly handicapped by the difficulty of finding otherwise suitable operations that were cutting enough of these species to afford the required number of measurements within any reasonable time. The results of this study are now being compiled at the Forest Products Laboratory.

Natural Replacement of Blight-Killed Chestnut

As indicated in last year's report, the study to determine the nature, extent, and rate of natural replacement of blight-killed chestnut and the rate at which the restocking and crown cover of the forest will be restored by the replacement species has been conducted in the Southern Appalachian region mainly by means of permanent sample plots.

If replacement is deficient anywhere, it should logically be expected in stands that are predominately chestnut. To determine the replacement conditions in stands running heavily to chestnut two one-acre permanent plots were established in 1928 on the Natural Bridge National Forest near Hotel Mons, Virginia, where the office of Forest Pathology, Bureau of Plant Industry previously established plots to study the death rate of chestnut. One plot was laid out in the chestnut-red oak type on a north-facing slope whose chestnut comprised 80 per cent of the stand by basal area. The other plot was established on a south-facing slope in the chestnut oak-chestnut type in which chestnut comprised 75 per cent of the original stand. On these

plots all trees over one-half inch in diameter were tagged and described and horizontal crown projection maps were made. In addition 40 milacre quadrats (each 6.6 feet square) were established on each plot; on these all trees were tagged.

The milacre reproduction quadrats on the Bent Creek chestnut replacement plots established last year were examined in the autumn of 1928. The results from the quadrats on the plots where the chestnut was removed in a salvage cutting--followed by a liberation cutting of all trees of undesirable species and form--were very marked. There was a very large turn-over of seedlings during the year after the plots were established, in many cases nearly 100 per cent. Also the advent of new seedlings during the past year has been remarkable, in most cases more than 100 per cent of the total stand at the last measurement. One plot in the cove hardwood type stands out particularly in the many quadrats showing 30 to 50 thousand new (1928) yellow poplar seedlings per acre. Since this examination was made the year following the cutting too much weight can not be given the results but the possibilities are very promising.

Germination and Early Survival of Important Southern Appalachian Oaks

Acorns of white, scarlet, and chestnut oak were stored over winter by three different methods. The germination of these stored acorns was determined in the spring of 1928. The white and chestnut acorns stored in running creek water germinated during the first two weeks in storage and were found to have lost their viability by spring. Since the scarlet oak acorns must pass through a rest period prior to germination, these acorns were viable when removed, but had germinated sufficiently to have tender roots about one-half inch long protruding from the acorn. These roots were easily broken off in handling. The white and chestnut oak acorns stratified in sand and buried 3 feet under ground also germinated during the warm autumn weather, and when removed from the storage pit the middle of March had roots 1 to 3 inches long and also were difficult to handle.

The acorns which had been overwintered in cold storage at about 35° to 40° F were in the best condition for planting and gave very satisfactory germination in the nursery. Where, because of danger of rodent damage, acorns cannot be safely planted in the autumn soon after collecting, stratifying in sand in cold storage is the best method of overwintering in regions with warm autumns and winters.

The penetrometer used in the laboratory and greenhouse to study the compactness of surface soil in relation to the penetration of newly developed oak radicles was modified through the cooperation of Dr. Hursh of this Station, so as to obtain penetrability measurements of natural soil in place. With minor modifications in the matter of weights used, the instrument will be ready for field use in other projects.

Loblolly Pine Study

The study of the reproduction, growth and management of loblolly pine, begun in 1927, was continued during 1928. In 1927 it was found that increment borings taken on different sides of the tree varied as much as 200 per cent. In addition to checking this discrepancy it was considered desirable to round out the study of in-

creased growth following cutting by an intensive study on felled trees to determine the allocation of the increased growth on the stem and the possible changes in form of the trees remaining after cutting.

Permission was obtained from the Surry Lumber Company to fell 35 trees on their lands near Smithfield, Virginia, cutover 12 years previously. These trees were described in detail, felled, and sections taken at breast height, at ten-foot intervals up the tree to the base of the crown, and at five foot intervals above the base of the crown. These sections were coated with paraffin by dipping in a mixture of paraffine and gasoline and taken back to Asheville, where they were measured during the winter. Sections were also sent to the Forest Products Laboratory for use in a study of the quality of wood formed before and after release.

In order to facilitate the preparation of taper alinement charts by the multiple curvilinear correlation method the data was put on punch cards and run through the sorting and tabulating machines in Washington. This work remains to be finished during the spring and summer of 1929.

The strip data and that on increased growth after cutting obtained on cut-over areas in 1927 was also put on punch cards and run through the machines during the year. The final analysis of these data should be made in 1929. It is quite possible that some additional machine runs will also have to be made.

Tree Studies

Southern White Cedar

The study of the characterists, growth, and management of southern white cedar begun in 1921 in cooperation with the State Foresters of Virginia, North Carolina and New Jersey was virtually completed with the submission early in 1928 of the manuscript of a proposed Department bulletin. The manuscript is now being reviewed in Washington prior to publication.

Yellow Poplar

Work during 1928 on the study of yellow poplar, begun by E. F. McCarthy in 1921, consisted in the completion of a manuscript dealing with the characteristics, growth and management of this species. The manuscript has been submitted for publication as a Department bulletin and is being reviewed in Washington.

The Oaks

A field trip was made during April, 1928, by Field Assistant Scholz through the Piedmont section of the Carolinas and through northern Georgia and Alabama on a search for second-growth oak stands suitable for yield plot data. This trip was made at the request of E. F. McCarthy who carried the oak study with him to the Central States Forest Experiment Station. The extensive survey party studying cut-over mountain hardwood lands also kept a look out for stands suitable for yield tables but were unable to find any near the cut-over areas visited.

Forest Fire Studies

Physical structure of forest soils

in the Southern Appalachian Mountains

with Special Reference to the Effect of Fire

Work on this phase of fire damage was started in 1928 by Dr. Hursh at several points in the mountain region of North Carolina, Kentucky, and West Virginia. Localities were selected in which adjacent burned and unburned areas could be studied comparatively. The general procedure involved, first, a short survey to determine the soil types; and second, the observation of soil profiles at regular intervals along definite transects through the burned and unburned areas. The profiles were determined by digging soil pits, and the profile descriptions were recorded on a special form. Soil samples were collected for laboratory study of physical structure, water holding capacity, etc.

The records of the soil profiles include descriptions of the topographic position of each station, the underlying geologic formation, the soil development, and the nature and condition of the vegetative cover, which was found to differ for the different soil types. The forest floor was given particular attention and the soil profile was described in detail. A record was also kept of drainage conditions and erosion. Distribution of fine and large roots was recorded but no attempt has been made as yet to study root distribution in detail. Photographs were made of representative soil profiles.

During this study it became increasingly apparent that the destruction of the leaf litter by fire may greatly influence conditions governing the physical structure and fertility of the soil. It appeared that a study of the forest floor would be a profitable and tangible approach to the study of the soil beneath it. Observations of leaf litter under hardwoods in the Station's experimental forest at Bent Creek were accordingly made, in the interest both of the soil study and of the study of water absorptiveness to be reported on a later page. Determinations were made of the weight of litter from unit areas of one square yard taken every half chain along a strip through the area under observation, and the moisture content and water holding capacity of these samples was also determined. It is not only the amount of the leaf fall that is important, however; its distribution over the forest floor is significant, and the indications are that there is a considerable movement of litter during the fall and winter, before it has become compacted. This movement, from exposed ridges and slopes to ravines and depressions, is being studied to determine its rate and the factors that retard or check it.

In addition to the determination of the amount of litter present, collections of litter from individual tree species have been made. These collections will be used for analysis and further studies of the comparative fertilizer value of different species. The general field covered by the soils study was reviewed by Dr. Hursh for the Christmas issue of the Southern Lumberman in a paper entitled "Litter Keeps Forest Soil Productive".

Forestation

Tests of Species for Planting

Experiments to determine the species best suited for planting in the spruce-fir type were begun on the slopes of Clingman's Peak, in the Black Mountains of North Carolina, in March, 1923, and have been continued each spring with additional plots. The area originally supported a heavy growth of red spruce and southern balsam fir. Fires which followed the logging destroyed practically all softwood seedlings. The light snowfall and exposure to severe winter winds now present an unfavorable site for the establishment of a new stand. The sites selected for the larger blocks of experimental plots were a south and an east facing slope, at an elevation of between 5,500 and 6,000 feet, on which the heavy growth of pin cherry and yellow birch prevalent over large areas, was absent.

In 1928 four plots were added to the 53 established in the Clingman's Peak planting area in former years. The species planted in 1928 were Japanese red pine, Japanese larch, and northern white cedar. In addition, 30 seed spots of red spruce were sowed.

Small plantations of yellow poplar, yellow poplar and black walnut mixed, Scotch pine, Corsican pine, cottonwood, and red pine were made on or near the Bent Creek experimental forest, on the Pisgah National Forest. One hundred new yellow poplar seed spots were sown to test the effectiveness of seed spotting this species. Nine new plantings of 25 to 50 trees each were made in the Bent Creek arboretum. All the arboretum plantings were staked and mapped.

Forest Insect Investigations

The Turpentine Borer

Joint studies on the turpentine borer (Buprestis apricans Hlst) begun in 1926 by F. C. Craighead, of the Division of Forest Insects, Washington, D. C., Lenthall Wyman of the Southern Forest Experiment Station and J. A. Beal of the Division of Forest Insects, have been terminated and a manuscript is now in preparation. The study was undertaken in order to determine the extent of damage to turpentined timber, life history and habits of the beetle, and practical control measures. This borer which attacks exposed faces where fire, dry facing, or poor work has removed the protecting pitch coat, is the direct cause of heavy annual losses through windfall. It has been found that conservative operation of turpentine timber, as advocated by the Southern Forest Experiment Station, and protection from fire will go far in eliminating the damage caused by this insect. It is absolutely necessary to keep fire off turpentined faces to protect them from the borers.

The Locust Borer

Locust Borer studies were continued during the past year. Plots on which sprays were used revealed that arsenical sprays, orthodichlorobenzine emulsion sprays,

paradichlorohenzine and pine tar oil sprays gave very effective control against this insect if used before the larvae penetrated deeply into the wood.None of the sprays were effective against the locust borers after they had gotten into the wood. This means that in the vicinity of Asheville locust groves and plantations where spraying is practicable can be successfully treated against the locust borer during a limited period from about April first to May tenth. Locust plots at Lookingglass Rock where protection cover was removed by thinning have been attacked by the borers which have worked most actively on the locusts just above the shaded portions of the advancing young growth. Trees protected by shade show little or no damage by borers. This evidence, together with previous work on the locust borer, substantiates the theory that borer damage can be greatly reduced or eliminated by shading the trunks with some shade-producing undergrowth.

The Southern Pine Beetle

Studies on the southern pine beetle (Dendroctonus frontalis Zimm) were continued along similar lines as those described in the Report of the Station for 1927. The study of environmental factors governing epidemics of the southern pine beetle, biology of the bettle, studies on associated species, parasites, and enemies made up a major portion of the past season's work.

A study of reproduction following beetle kills has been started and about ten permanent sample plots have been laid out in beetle kills of different ages, the reproduction mapped, tagged and noted. It is hoped to answer the question of what can best be done on these devastated areas with a view to restocking them with preferred species.

Serious windstorms of the fall of 1928 resulted in heavy losses of timber in the southeastern states. It was thought advisable, because of the numerous requests regarding insects attacking logs and storm damaged timber, to issue briefs covering this phase of the problem. Therefore Beal prepared the following Forest Entomology Briefs for distribution, "The Southern Pine Sawyer" and "The Ips Bark Beetles". Tree injection experiments for the purpose of controlling injurious forest insects were continued as described in the previous report. It has been proved beyond doubt that pines which have been burned are especially attractive to the southern pine beetle. The beetles are able, under endemic conditions, to maintain themselves and carry on their activities in trees weakened by fire. This is another good argument against woods-burning in the southeast.

In the spring of 1928 a pine sawfly (Neodipron sp?) was found very abundantly defoliating shortleaf, scrub, and pitch pines. There proved to be but a single generation a year.

The southern pine beetle kept at a minimum for the past two years by unfavorable weather conditions, largely extreme winter cold and rainy summer seasons, has been inactive each summer up to July. The winter of 1928-29 was mild and no brood mortality was noted. Beetles were plentiful the following spring and promise to be fairly abundant during the summer of 1929.

Studies in Forest Pathology

A cooperative study with J. A. Beal on the relation between blue staining fungi and bark beetles in southern pines was undertaken during the past summer. A number of species of staining fungi were isolated from blued wood or from the beetles and grown on artificial media. Shortleaf and pitch pines were inoculated in a number of ways. The preliminary experiment indicates that the staining fungi are probably important factors in the rapid death of beetle attacked trees. Preliminary studies were also begun on the pathological anatomy and physiology of stained trees.

The hardwoods, and particularly the oaks in the Southern Appalachians, are attacked by a large number of heart rotting fungi. The identification of these fungi is necessary to a proper interpretation of data taken by pathologists in connection with the mill scale study carried on during the year, to future work in the study of fire scars, and to many other problems. A study of the organisms causing decay, grown in pure cultures on artificial media, affords in many cases the best means of identification or verification. In order to build up a type collection, over 600 specimens of sporophores and decayed wood were collected and cultured during the year. More than 1200 cultures of over 50 species of fungi are now in the collection and approximately 10,000 subcultures were made.

Studies by Hedgcock carried on over a number of years indicate that fire scars are the avenues of entrance for a very large percentage of the basal rots of hardwoods. A survey of burned areas preliminary to a detailed study of the entrance of heart rotting fungi through fire scars in oaks was made during the summer.

The investigation of the tannin content of dead chestnut trees with G. F. Gravatt has been completed and results are being prepared for publication. Analysis show that the loss in chestnut dead for even 20 to 30 years is not great. The chestnut extract industries will be able to use trees killed by the blight, for a long time in the future and the partial salvage of dead chestnut is thus possible.

Biological Investigations

This title had been given to studies of mammals, birds, and other animal life in the forest, with reference to its value as game and its harmful or beneficial effect upon tree growth and reproduction. A beginning was made through the assignment of Mr. A. H. Howell of the Biological Survey to conduct a spring census of mammal and bird life and an investigation of feeding habits in the Asheville region. This assignment followed a recommendation by the Appalachian Forest Research Council. Mr. Howell, assisted by Dr. Hursh, made an analysis of the fauna of three representative forest types of the region. These were the oak-pine type, the chestnut oak type, and the cove type. The areas were systematically trapped for rodents, and a census of birds and other animals was made for each area. This census was correlated with the tree reproduction determined for each area by strip tallies. Mr. Howell furnished a report of the census, together with an analysis of stomach contents from the animals taken. A marked extension of range was discovered and a new form of the

red squirrel was obtained on Mount Mitchell. This was described by Mr. Howell in an article in the Journal of Mammalogy, for February, 1929. Mr. Harold Heffley, a graduate student at Duke University, spent two weeks on the experimental forest at Bent Creek getting material for his doctor's thesis on the ecological relations of rodent parasites. Heffley's stay overlapped that of Mr. Howell and they worked in close cooperation. Every rodent captured served at least a dual purpose.

Weather

An exceptional drought in 1925 resulted in the browning and apparent death of large numbers of forest trees. Weather Bureau records for Asheville showed a deficit of about 18 inches below the normal precipitation of about 40 inches. This deficit occurred mostly in the summer. The damage to the timber occurred in conspicuous strips and patches, chiefly on the upper slopes and ridges. The plan for the study of the effects of this drought, begun by F. W. Haasis in 1925, called for an examination of the affected trees in the summer or fall of 1928. Due to Haasis' resignation and the pressure of other more important work this examination had to be postponed. It will be made in 1929 and a report prepared for publication.

Forests, Stream-Flow, and Erosion

Although this subject has not yet appeared on the Station's investigative programs, the wide-spread damage done by heavy rainfall, through erosion, land-slides, injury of water-courses, sliding of reservoirs, etc., point to the need of thoroughgoing investigations to determine the possible function of the forest in reducing these sources of damage. A study of the damage from the 1916 freshet in Western North Carolina led to the conclusion that cut-over and burned forest conditions were largely responsible. On August 15, 1928, a heavy rain occurred in the mountain region, resulting in a 12-foot flood stage in the French Broad River at Asheville. The Station was requested to make observations and supply data on the relative amounts of suspended matter carried by flooded streams draining cleared and forested lands. Samples of water were accordingly collected by Dr. Korstian from various flooded streams near Asheville, and the load determined. The results are shown in the following tabulation:

Approx. percentage of forest land on watershed above point of sampling.	Amount of suspended matter in parts per million.*	Kind of suspended matter.
Per cent 95	4	Mostly particles of organic-matter, some fine sand.
90-95	11	Mostly particles of organic matter, some fine sand.
40-45	107	Organic matter, fine sand silt, and clay.
30-35	3,405	Mostly sand, some silt, little organic matter.
10-15	4,370	Mostly clay and silt, some fine sand, very little organic matter.

*Determined on basis of dry weight of suspended matter per weight of given volume of water.

From the precipitation records it is evident that the soil and the litter of the forest floor had been well saturated during the rainy period of August 4 to 12, on the last two days of which over one and a half inches of rain fell. The saturated condition of the soil and forest litter resulted in heavy run-off from the forested land as well as the cleared land, during the storm of August 15 and 16.

The chief difference, however, lay in the much greater load of suspended matter carried by the streams draining the cleared land. The large amount of material carried from the cleared land can only be fully appreciated when considered in conjunction with stream flow records of which none are available for this flood.

The nature of the load carried by the streams arising in the forested areas also affords an interesting comparison with that carried by the streams arising in or flowing through cleared land. The suspended matter contained in the water of the forest streams consists chiefly of particles of organic matter as minute pieces of leaves, partly rotted wood, etc., and a small amount of fine sand, while that contained in the water of the streams draining cleared land is mostly clay, much of which is colloidal and will remain in suspension indefinitely and capable of being carried long distances with some silt and sand but very little organic matter. In one case the load carried by the stream was mostly sand which was undoubtedly carried along for short distances at a time but was successively dropped and picked up again. The streams with a high percentage of forest cover on the watersheds were strikingly clear, while the streams draining large areas of cleared land were unusually turbid, particularly those carrying a heavy load of clay and silt.

Another request for information upon the relation of forests to water led to observations of the water retentive capacity of the forest soil. Dr. Hursh collected and analyzed a large number of leaf litter samples from the hardwood forest floor in the Bent Creek experimental forest. The actual weight of the litter, per acre, was estimated from samples of one square yard collected every half-chain along a strip through the forest under observation. The weight varied greatly under different conditions. It was least --1,791 pounds per acre on pastured and browsed slope, and greatest--- over 8 tons-- on a lower south slope. The moisture content was determined by weighing samples before and after drying them in a regulated oven at 90°C. The water holding capacity was similarly determined by weighing samples when throughly soaked with water and subsequently determining the moisture loss by drying. These determinations indicated a total water holding capacity, per acre, of from 4,482 pounds of water, for pastured and browsed slope, to 54,532 pounds, for middle and upper north slope

Summary of Projects Completed in 1928

Timber growing and logging practice in the Southern Appalachian region. Final report submitted for publication.

Southern white cedar: its characteristics, growth and management. Manuscript submitted for publication.

Yellow poplar: its characteristics, growth and management. Project transferred, with E. F. McCarthy, to Central States Forest Experiment Station. Manuscript submitted for publication.

One other project study of growth and yield of oaks, was carried to the Central States Station by McCarthy, though the Appalachian Station is expected to cooperate in getting such measurements as may be needed. This project should be closed, so far as the Appalachian Station is concerned, as soon as the field work is completed.

PLANS FOR 1929

The following work is proposed for 1929:

Management

Methods of Cutting and Natural Reproduction-Hardwoods

The extensive survey of cut-over areas is to be continued on the Robinson sub-station tract of the Kentucky Agricultural Experiment Station, and in West Virginia, on lands of the Pocahontas Coal Company, the Monongahela National Forest, or the State forests in Pocahontas County. Permanent sample plots at Bent Creek and Curtis Creek, N. C., and North Mountain, Va., are to be reexamined. Weeding experiments are to be started in one of the plots at Berea. Additional plots are to be established in cut-over forest to test various methods of treatment recommended in the bulletin on "Timber Growing and Logging Practice." A start is to be made toward drawing up a scheme of tree classification, relating species, crown size and thrift, bole condition, etc., to rate of growth and reproductive efficiency.

Reproduction, Growth, and Management of Cut over

Loblolly Pine Lands.

Computing work to be brought up to date during the summer of 1929. Extensive survey work to be continued in the Carolinas and Virginia. A soils study to be made, as a basis for selection of branch stations and interpretations of data. Program of Coastal Plain work to be formulated, including recommendations for branch stations.

Natural Replacement of Chestnut

Quadrats on the Bent Creek and North Mountain plots to be examined in the fall of 1929, but no additional plots to be established.

Natural Reproduction in the Spruce-fir Type

Manuscript to be completed for publication, and project closed.

Germination and Early Survival of Oaks

Project to be closed in 1929 after a report is prepared for publication as an article.

Bent Creek Experimental Forest

Subdivision of this tract into compartments and subcompartments to be finished. A management plan to be made. Plans to be made for an additional small dwelling and garage.

Biltmore Thinnings

Treated plots to be marked for thinning if indicated by the condition of the stand. Thinning to be done in cooperation with the Biltmore Estate. Wood samples from trees removed from thinning to be sent to the Forest Products Laboratory, for tests. (All plots were thinned in April 1929, and 200 sections sent to Madison.)

Thinnings in Mountain Second-growth

Plots established in second-growth yellow poplar at Cranberry, N. C., in fall of 1928 to be thinned in spring of 1929. (This was done in April, 1929.)

Thinnings in Loblolly and Other Southern Pines.

No work scheduled for 1929 other than preparation of a working plan.

Protection - Fire

Forest Fire Damage

It is recommended that the title of this project be changed to "Effects of forest fire upon site, growth rate, reproduction, and quality of timber in the mountain region." It is proposed (1) to extend the soils phase to include studies of forest litter and some of the more important effects of biological activities, since these were shown during last season's work to be inseparable from physical soil properties and closely related to the effect of fire upon soil quality; and (2) to begin sample plot experiments to determine the effect of periodic burning upon the mortality and condition of reproduction and timber stand, by species, and upon growth rate.

Effect of Controlled Burning in Loblolly Pine and

Longleaf Pine Types

Project taken over in 1928 with the transfer of South Carolina from the Southern Station to the Appalachian Station territory. Plots established at Lanes, S. C. to be continued. Burning to be done in January and December. (The treated area was reburned in January and reexamined in April, 1929). A revised working plan to be prepared. Arrangements have been made to have the plots examined periodically by an entomologist and a pathologist.

Mensuration

Growth Sample Plots (Mountain Region).

Plots at Star Gap, Pisgah National Forest, to be measured. Other plots to be laid out if opportunities arise in connection with the methods of cutting project.

Forestation

Tests of Species for Planting in the Spruce-fir Type

Experimental plantings on Clingman's Peak, in the Black Mountains, N. C., to be continued on a limited scale, and examinations to be made of the 1927 and 1928 plantings. (This was done in April, 1929, and 10 additional chain-square plots were planted).

Tests of Species for Planting in the Hardwood Types

Map of arboretum, laboratory, and grounds to be revised. Sketch map and working plan of proposed development of arboretum to be prepared. Additional species to be planted as they become available.

General Study of Plantations

To be continued as a file project; records of plantations to be made as opportunities permit. Permanent plots to be established where conditions are especially favorable.

Forest Insect Investigations

Southern Pine Beetle

A bulletin on this beetle was prepared and put into manuscript by R. A. St. George and J. A. Beal and is now ready for distribution. The interrelation of blue stain fungi and the southern pine beetle, a joint problem with the office of Forest Pathology, was reported upon in a paper prepared for publication by Nelson and Beal. Further studies will be made on natural factors affecting beetle abundance. Plots in windspread pine areas will furnish the basis for part of these studies.

The Turpentine Borer

This project has been completed and the materials will be compiled into bulletin form in 1929 for early publication.

Locust Borer

Studies on artificial and silvicultural control will be continued. The advisability of advocating the planting of yellow locust instead of black (some Foresters state that there is considerable difference between the two) will be tested.

Insects in Relation to Fire

This problem will be continued.

Tree Injection

Efforts will be centered around developing better methods of injection and many tests will be made to determine the distribution of the materials throughout the injected trees.

Forest Pathology

Investigative work for the next year will be largely confined to three major projects; blue stain experiments, cultural studies of heart rotting fungi, and investigations on the entrance of decay through fire scars in Oaks.

Blue Stain

A large number of conifers will be inoculated with blue stain fungi and it is hoped that the role which these fungi play in the death of beetle attacked trees will be conclusively demonstrated. Histological studies of stained wood and investigations on the disturbed physiological activities of trees attacked by bark beetles and blue staining fungi will be carried on in detail.

Cultural Studies of Heart Rotting Fungi

A considerable part of the time will be spent in building up the collection of rots, sporophores and cultures,-- leading eventually to the preparation of a key to the cultural characteristics whereby the identity of the fungi causing heart rots may be determined or verified.

Entrance of Fungi Through Fire Scars in Oak

The general survey of burned areas will be completed and a critical examination of scars begun. The effect of severity of fires, topographic and seasonal factors, multiple burns, and the mycologic succession in scars will be studied.

Biological Investigations.

Plans for biological studies will be postponed until a man is definitely assigned to conduct the work. It is understood that a biological specialist is to be assigned to the Station by the Biological Survey in the first part of the fiscal year, beginning July 1, 1929.

Weather

Effects of the 1925 drought. A final report to be prepared based upon examination of the plots established by Ferdinand W. Haasis at Bent Creek.

Botanical Studies

Phenology

A new project, the purpose of which is to assemble information upon the seasonal changes in life process and the period of growth of trees and associated plants as affected by climate. A plan for collecting data will be prepared, including methods of analyzing data and the organization of cooperative observers.

ALL-SERVICE PROJECTS

Preparation of Manuals on Silvical Research Methods

Conducted by E. N. Munns, for the Washington Office, in collaboration with the various forest experiment stations. A manual on permanent sample plots to be completed, and one on field technique to be prepared.

Present and Potential Growth and Yields of the Forest Regions of the United States

A current project at all of the forest experiment stations in connection with the more intensive studies of growth and yield and observations of forest conditions.

BRANCH STATION ACTIVITIES PLANNED

It is proposed to continue on a more intensive scale the analysis of conditions throughout the region from the available records of soil, geology, and climate. This is to serve as a means of classifying the region into provinces for the better selection of branch stations.

On the coastal plain, a number of suggestions of branch station possibilities were examined and found unsuitable. Promising cooperative conditions were found in South Carolina at Lane's where work on controlled burning, taken over from the Southern Station, is already under way; ay Pregnall, where the Southern Railway is operating a 10,000 acre demonstration forest, and at Drainland, where experiments in cooperation between the Forest Service and Clemson College have been under way since 1912. The logical point is summerville, S. C., near which there appears to be other promising opportunities (in cooperation with lumber companies that are protecting their lands and logging for a second cut) that are yet to be investigated. Locations near Burgaw, N. C., and Franklin, Va., have also been examined. Favorable conditions were found at both points. At Franklin, the Camp Manufacturing Company is practicing selective cutting and carefully protecting its lands. Excellent cooperative arrangements can be made at any of these points. Definite recommendations for the establishment of branch stations in the Coastal Plain will be deferred until after the further analysis of prevailing forest and soil conditions which it is proposed to undertake this year.

In the mountain region, the situation in West Virginia will be reviewed in order to decide upon at least one representative location for a branch station. One or two other branch station possibilities in the Appalachian Mountains have been suggested within the last two years, and these also will be investigated and reported upon in connection with the regional climatic, geologic, and soil analysis already mentioned.

IMPORTANT SUBJECTS FOR FUTURE INVESTIGATION

New subjects for investigation are frequently suggested or are disclosed during the work on the regular projects . Three of these appear to be of outstanding importance.

The need of a comprehensive study of forests in relation to stream-flow and erosion has been referred to on other pages of this report. In "Soil Erosion a National Menace", (U. S. Dept. of Agriculture Circular 33. 1928) H. H. Bennett has vividly described the enormous destruction due to erosion over large areas in the Southern Appalachian region. "As a Nation", says Bennett, "we are doing very little to abate the evil effects of erosion. Every one who knows anything about it admits the problem is a serious one, but few realize how very devastating is the wholesale operation of erosion." The material eroded fills reservoirs, shortens their life, and chokes stream beds. The severe damage done by freshets following storms in the mountain region, and the evidence that connects a part of this damage with poor forested conditions on the mountain slopes, have already been referred to in this report.

The Station has had in prospect a study of forests and stream flow for several years, but the demands of such a study in time and personnel have put it out of the question until adequate resources could be obtained to handle it. The Station believes that this investigation should be delayed no longer, and strongly recommends that the necessary steps be taken to begin work on it next year.

Another subject of leading importance is the broad economic problem of cut-over timberlands in the mountain and coastal regions. Recent studies by the Station have shown that much of this land is poorly productive in its present condition. With millions of acres of such land under private ownership, the questions of taxation, current valuation, true valuation ,soil qualities and growth possibilities, fire damage and fire prevention, costs of ownership, and possible returns from timber production and other uses, ought to be solved in the interest of the owners and of the region as a whole. Such a study should be from a number of angles, economic as well as silvicultural. The Station is at present equipped to carry on only the limited silvicultural investigations of cut-over areas that have been described in this report. It is felt that the importance of the problem justifies a much more comprehensive study, and that special provisions should be made for it as soon as possible.

A study of selective cutting as compared with the usual commercial logging should be undertaken in 1930, on relatively large areas of loblolly pine land, in order to determine the relative advantages of such cutting to the land owner and the mill operator. The study should involve determining the rate of growth of the trees cut, the increased growth of the remaining stand and the amount and rate of restocking the different methods of partial cutting; the determination of various silvicultural measures and their costs, such as methods of cutting, slash disposal, subsequent thinning where such becomes desirable; and the artificial restoration of the stand on the clear cut area. This study should also include an accurate determination of the costs of logging and milling trees of various sizes; the ratio of merchantable products to slabs, saw-dust, edgings, and other unmerchantable material for each size class; and the quality and value of lumber and other products that may be obtained from milling trees of each size class within the entire diameter range of the forest. The cooperation of the Forest Products Laboratory and the land owner and operator will be necessary in this study.

One large and important part of the Station's territory — The Piedmont Plateau has so far been almost entirely neglected in the investigative work. This is true also of the Alleghany and Cumberland Plateaus and the Appalachian Valley. The forest is practically all in farm woods, very accessible to markets and of high actual and potential value to the region as a whole. The timberland area of the plateaus and valley is about 39,000,000 -- approximately 64 per cent of the forested area of the entire region. The extent and value of these timberlands call for special investigations of the problems peculiar to them, and studies should be undertaken by the Station as soon as the necessary funds and personnel can be provided for them.

Active Projects in Order of Importance*

1. Methods of cutting and natural reproduction - hardwoods (Mc-2).
   Frothingham, Buell, and Sims.

2. Reproduction, growth ,and management of lobolly pine (M-111).
   Korstian and MacKinney.

3. Bent Creek experiment forest (M-Bent Creek forest).
   Buell, in consultation with Frothingham and Korstian.

4. Effects of forest fire (Pf, A-1)
   Hursh, assisted by Sims.

5. Effect of controlled burning, coastal plain (Pf, C-3).
   Korstian and MacKinney.

6. Thinnings: Mountain second-growth (Mt-2)
   Buell.

7. Growth sample plots (ME-1)
   Frothingham and Sims.

8. Natural replacement of chestnut (M-3)
   Korstian and MacKinney.

9. Thinnings: Biltmore Estate (Mt-1).
   Frothingham.

10. Tests of species: planting in the spruce type (Fp-3).
    Sims, in consultation with Korstian.

11. Effects of the 1925 drought (Pw-1).
    Hursh.

12. Tests of species: planting in hardwood types (Fp-4).
    Sims, in consultation with Korstian.

13. Phenology (Botanical Studies).
    Buell.

14. Thinnings: loblolly and other southern pines (Mt-3).
    MacKinney.

15. General study of plantations (Fp-2).
    Sims.

---

* "Importance" based upon estimated amount of time and number of men to be given the projects in 1929. Projects in forest entomology, pathology, and biology are not included in this list.

PERMANENT SAMPLE PLOTS

Size, Treatment, and Dates

Location and purpose	Plot No.	Size Acres	Treatment	Established	Next examination Major Plot	Next examination Quadrats
Asheville Branch						
Bent Creek						
Fire damage	1	.4	Burned	1925	1929	None
" "	2	.15	Control	1925	1929	"
" "	5	.9	Burned	1925	1929	"
Hdwd reproduction	3	.25	Burned & cut-over	1925	1929	1929
" "	4	.15	Cut-over	1925	1929	1929
" "	25	1.00	"	1928	1932	1929
Chestnut replacement	6	1.00	"	1927	1931	1929
" "	7	1.00	"	1927	1931	1929
" "	8	1.00	Control	1927	1931	1929
" "	9	1.00	"	1927	1931	1929
" "	10	1.00	Cut-over	1927	1931	1929
" "	11	.50	"	1927	1931	1929
" "	15	.50	"	1927	1931	1929
" "	Sq.rd 1-50	1/160	1-40 none 41-50 planted	1927-1928	1929	None
Planting tests	A1-19	Various	Planted	1926-28	1929	"
" "	B1- 6	"	"	1926-27	1929	"
" "	C1-4	"	"	1926-27	1929	"
" "	12	.15	"	1928	1929	"
" "	13	.09	"	1928	1929	"
" "	14	1.00	"	1928	1929	"
" "	16	.18	"	1928	1929	"
" "	17	.27	"	1928	1929	"
" "	18	1.01	"	1928	1929	"
" "	19	1.12	"	1928	1929	"
" "	20	.54	"	1928	1929	"
" "	21	.88	"	1928	1929	"
" "	22	.21	"	1928	1929	"
" "	23	.37	"	1928	1929	"
" "	24	.29	"	1928	1929	"
Biltmore Estate						
Thinnings - pine	1a	.25	Thinned	1916	1933	None
" "	1b	.125	Control	1916	1933	"
" "	1c	.125	"	1916	1933	"
" "	2a	.10	Thinned	1916	1933	"
" "	2b	.10	Control	1916	1933	"
" maple	3a	.05	Thinned	1916	1933	"
" "	3b	.05	Control	1916	1933	"
" pine	4a	.125	Thinned	1916	1933	"
" "	4b	.08	Control	1916	1933	"
Cranberry						
Thinnings, hdwds	1	.25	Thinned	1920	1933	None
" "	2	.10	Thinned	1920	1933	"

CONT'D

	Plot No.	Size Acres	Treatment	Established	Next examination Major Plot	Next examination Quadrats
Asheville Branch						
Mt. Mitchell						
Planting tests	A1-24	.10	Planted	1923-28	1929	None
" "	B1-31	.10	"	" "	"	"
" "	C1	Irreg.	"	1925	"	"
" "	D 1-2	.07	"	1926	"	"
" "	E 1-2	.07	"	1926	"	"
Curtis Creek						
Hdwd reproduction	1	.25	Cut-over	1922	"	1929
" "	2	.25	" "	1922	"	"
Growth, young stands	3	.40	None	1926	"	"
" " "	4	.40	"	1926	"	"
Harper's Creek						
Fire damage	1	.50	Burned, 1926	1926	"	"
" "	2	.60	" "	1926	"	"
" "	3	.60	" "	1926	"	"
Pritchard Creek						
Fire damage	1	3.00	Burned, 1922	1923	"	"
" "	2	1.00	" "	1923	"	"
" "	3	1.25	" "	1923	"	"
" "	4	1.25	" "	1923	"	"
Lookingglass Rock						
Hdwd reproduction	1	.5	Control	1923	1933	1929
" "	2	.5	"	1923	"	"
" "	3	.5	Liberation	1923	"	"
" "	4	.5	"	1923	"	"
Stony Fork						
Hdwd reproduction	1	1.0	Cut-over	1928	1933	1929
Berea Branch						
Berea College Forest						
Hdwd Reproduction	1	2.8	Cut-over	1923	1933	1930
" "	2	.5	Control	1923	"	"
" "	3	3.5	Cut-over	1923	"	"
" "	4	1.0	Control	1923	"	"
Growth young stands	5	.5	None	1926	1930	1930
" " "	6	.5	"	1926	1930	1930
Edinburg Branch						
North Mountain						
Hdwd reproduction	1	1.05	Cut-over	1924	1929	1929
" "	2	.50	Control	1924	1929	1929
" "	5	.50	Cut-over	1924	1929	1929
" "	6	.25	Control	1924	1929	1929
" "	8	1.00	Cut-over	1927	1932	1929
Chestnut replacement	9	1.00	" "	1927	1932	1929
Thinnings, hdwds	3	.50	Thinned	1924	1929	1929
" "	4	.33	Control	1924	1929	1929
" "	7	1.00	Thinned	1927	1932	1929

CONT'D

	Plot No.	Size Acres	Treatment	Established	Next examination Major Plot	Next examination Quadrats
Edinburg Branch						
Home Quarry						
Hdwd reproduction	3	.50	Cut-over	1923	1929	1929
Bartlett Sale, Shenandoah N.F.						
Release cutting	1	.25	Cut-over	1926	1929	1929
" "	2	.125	Control	"	"	"
Hotel Mons						
Chestnut replacement	1	1.00	None	1928	1933	1930
" "	2	1.00	"	"	"	"
Beaver Dam ,Va.						
Page Estate						
Thinnings, pine	1	.25	Thinned	1913	1930	None
" "	2	.25	"	1913	1930	"
" "	3	.125	Control	1913	1930	"
Old Lee National Forest, Va						
Thinnings, pine	1	.25	Thinned	1927	1930	None
" "	2	.25	"	"	"	"
" "	3	.25	Control	"	"	"
Pregnall, S. C.						
Thinnings, pine	1	.23	Thinned	1925	1930	None
" "	2	.23	"	"	"	"
" "	3	.23	"	"	"	"
" "	4	.23	"	"	"	"
" "	5	.23	Control	"	"	"
Lanes, S. C.						
Controlled burning	1	.15	None	1929	1931	1929
" "	2	.05	"	1924	"	"
" "	3	.25	"	1929	"	"
" "	4	.25	"	"	"	"
" "	5	.25	"	"	"	"
" "	7A	.05	Burned ann.	1924	"	"
" "	7B	.05	" "	1929	"	"
" "	8	.25	" "	"	"	"
" "	9	.25	" "	"	"	"
" "	10	.25	" "	"	"	"
" "	11	.25	" "	"	"	"
" "	12	.25	" "	"	"	"
" "	16	.10	" "	"	"	"
" "	18	.05	" "	1924	"	"
" "	21	.25	None	1929	"	"
" "	23	.10	Burned ann.	"	"	"
" "	24	.05	" "	1924	"	"
" "	25	.15	" "	1929	"	"
" "	26	.15	" "	"	"	"
" "	27	.25	" "	"	"	"
" "	28	.30	None	"	"	"
" "	29	.05	"	"	"	"
" "	30	.05	"	"	"	"

PERMANENT SAMPLE PLOTS

Forest Type and Interval between Measurements

Location and purpose	Plot No.	Forest type	Interval between measurements (years)	
			Major plot	Quadrat
Asheville Branch				
Bent Creek				
Fire damage	1	Shortleaf pine	5	None
" "	2	" "	5	"
" "	5	Black oak-scarlet oak	5	"
Hdwd reproduction	3	Cove hardwoods	5	2
" "	4	" "	5	"
" "	25	" "	5	1-2
Chestnut replacement	6	Chestnut	5	1
" "	7	"	5	1-2
" "	8	"	5	1-2
" "	9	"	5	1-2
" "	10	"	5	1-2
" "	11	"	5	1-2
" "	15	"	5	1-2
" "	sq.rd. 1-50	"	none	1-2
Planting tests	A 1-19	Old field	1-3	None
" "	B 1-6	" "	"	"
" "	C 1-4	" "	"	"
" "	12	" "	"	"
" "	13	" "	"	"
" "	14	" "	"	"
" "	16	" "	"	"
" "	17	" "	"	"
" "	18	" "	"	"
" "	19	" "	"	"
" "	20	" "	"	"
" "	21	"	"	"
" "	22	" "	"	"
" "	23	" "	"	"
" "	24	" "	"	"
Biltmore Estate				
Thinnings, pine	1a	White pine	5-6	None
" "	1b	" "	"	"
" "	1c	" "	"	"
" "	2a	" "	"	"
" "	2b	" "	"	"
" maple	3a	Sugar maple	"	"
" "	3b	" "	"	"
" pine	4a	White pine	"	"
" "	4b	" "	"	"
Cranberry				
Thinnings, hdwds	1	Yellow poplar	5	None
" "	2	" "	5	"

CONT'D

Location and purpose	Plot No.	Forest type	Interval between measurements (years)	
			Major plot	Quadrat
Asheville Branch				
Mt. Mitchell				
Planting tests	A1-24	Spruce -fir (cut or burned)	1-3	None
" "				
" "	B1-31	Do.	"	"
" "	C1	"	"	"
" "	D1-2	"	"	"
" "	E1-2	"	"	"
Curtis Creek				
Hdwd reproduction	1	Cove hardwoods	5	2
" "	2	" "	1	"
Growth, young stands	3	" "	2-3	"
" " "	4	" "	"	"
Harper's Creek				
Fire damage	1	Cove hardwoods	2	2
" "	2	Chestnut	2	2
" "	3	"	2	2
Pritchard Creek				
Fire damage	1	Pitch pine	2	None
" "	2	" "	"	"
" "	3	Cove hardwoods	"	"
" "	4	Black oak-scarlet-oak	"	"
Lookingglass Rock				
Hardwd reproduction	1	Cove hardwoods	5	2
" "	2	" "	"	"
" "	3	" "	3	"
" "	4	" "	"	"
Stony Fork				
Hdwd reproduction	11	Basswood-r.oak-chest.	5	1-2
Berea Branch				
Berea College Forest				
Hdwd. reproduction	1	Cove hardwoods	"	2
" "	2	" "	"	"
" "	3	" "	"	"
" "	4	" "	"	"
Growth, young stands	5	Old field	2	"
" " "	6	" "	"	"
Edinburg Branch				
North Mountain				
Hdwd reproduction	1	Chestnut oak	5	2
" "	2	" "	"	"
" "	5	Cove hardwoods	"	"
" "	6	" "	"	"
" "	8	Chestnut oak	"	"
Chestnut replacement	9	Chestnut-chestnut oak	"	"
Thinnings, hardwoods	3	" " "	"	"
" "	4	" " "	"	"
" "	7	Pine-oak	"	"
Hone Quarry				
Hdwd reproduction	3	Cove hardwoods	5	2

CONT'D

Location and purpose	Plot No.	Forest type	Interval between measurements	
			Major plot	Quadrat
Edinburg Branch				
Bartley Sale, Shenandoah National Forest				
Release cutting	1	White pine	2	2
" "	2	" "	2	"
Hotel Mons, Va.				
Chestnut replacement	1	Chestnut	5	2
" "	2	"	5	"
Beaver Dam, Va.				
Page Estate				
Thinnings, pine	1	Shortleaf pine	5	None
" "	2	" "	"	"
" "	3	" "	"	"
Camp Lee, Va.				
Thinnings, pine	1	Loblolly pine	3-5	None
" "	2	" "	"	"
" "	3	" "	"	"
Pregnall, S. C.				
Thinnings, pine	1	Longleaf pine	5	None
" "	2	" "	"	"
" "	3	" "	"	"
" "	4	" "	"	"
" "	5	" "	"	"
Lanes, S. C.				
Controlled burning	1	Longleaf pine (repro.)	3-5	½-1
" "	2	"" "	"	"
" "	3	" " (poles)	"	"
" "	4	" " "	"	"
" "	5	" " "	"	"
" "	7A	" " (repro.)	"	"
" "	7B	" " "	"	"
" "	8	" " (Poles)	"	"
" "	9	" " "	"	"
" "	10	" " "	"	"
" "	11	" " "	"	"
" "	12	" " "	"	"
" "	16	Loblolly " "	"	"
" "	18	" "(Saplings)	"	"
" "	21	Longleaf pine (poles)	"	"
" "	23	" " (repro.)	"	"
" "	24	Loblolly " "	"	"
" "	25	" " (Poles)	"	"
" "	26	" " "	"	"
" "	27	Longleaf " "	"	"
" "	28	Loblolly " "	"	"
" "	29	" " (Saplgs)	"	"
" "	30	" " (repro.)	"	"

ARTICLES PREPARED OR PUBLISHED, 1928

Frothingham, E. H. - Forest conservation in the Southern Appalachian region, with special reference to power development and the protection of streamflow. (Address, Southern Appalachian Power Conference, Atlanta.

Cut-over lands and forestry in the Southern Appalachians. For Gopher Peavy, Yearbook of the Minnesota Forest School.

Timber growing and logging practice in the Southern Appalachian region. For Department of Agriculture Bulletin. (Submitted in March, 1929.)

Korstian, C. F. - Chestnut killed by blight replaced by other valuable trees. U.S.D.A. Yearbook, 1927, pp. 179-181.

Timber from southern white cedar pays on coastal swamp land. U.S.D.A. Yearbook, 1927, pp. 617-619.

Intermountain brush lands not potential western yellow pine stands. Forest Worker, May, 1928. pp. 10-11.

Southern white cedar: its characteristics, growth, and management. To Board of Review.

America bids goodbye to her chestnut. To Economic Geography.

Hursh, C. R. - The reaction of plant stems to fungous products. Phytopathology 18: 603-610. July, 1928.

Litter keeps forest soil productive. Southern Lumberman, Vol. 133, No. 1734, pp. 219-221. December 22, 1928.

Haasis, F. W. - Germinative energy of lots of coniferous tree seed, as related to incubation temperature and to duration of incubation. Plant Physiology 4: 365-412.

Forest plantations at Biltmore, N. C. For Department of Agriculture Circular.

Buell, J. H. - What can be done with Southern Appalachian cut-over areas? Southern Lumberman, Vol. 133, No. 1734, pp. 211-212. December 22, 1928.

MacKinney, A. L. - Effects of forest litter on soil temperature and soil freezing in autumn and winter. For Ecology.

Beal, J. A. - The development of the proventriculus of Pityogenes Hopkinsi Swaine. Annals of the Entomological Society of America. December, 1927.

St. George, R. A., and Beal, J. A. - The southern pine beetle. For Department of Agriculture Bulletin.

Nelson, R M. - Protection of our forests against disease. Mimeographed radio address. Printed in Southern Lumberman, August 11, 1928.

Howell, A. H. - The relation of wild life to the forest. Mimeographed radio address.

ARTICLES TO BE PREPARED IN 1929

Frothingham, E. H. and Buell, J. H.	Making the most of cut-over areas in the Southern Appalachians. Journal of Forestry.
Korstian, C. F.	The Southern Appalachian spruce forest as affected by logging and fire. Department Bulletin.
	The storage of acorns in the southern United States. Journal of Forestry.
Hursh, C. R. and Haasis, F. W.	Topography and soil depth as related to drought injury in forest trees of the Southern Appalachian mountains. For a technical journal.
Hursh, C. R.	Effect of repeated burning upon soil conditions in the Southern Appalachian hardwood forests. For a technical and a popular journal.
	The place of research in forestry. Radio address delivered in March, 1929.
	Litter development rate and its relation to the development of the soil profile in the Southern Appalachian mountains. Technical journal.
	Comparative fertilizer value of litter from different tree species. Technical and popular journals.
	Herbaceous site indicators in the Southern Appalachian hardwood forests. Technical and popular journals.
Hursh, C. R and Buell, J. H.	The upper south and west dry slopes of the Southern Appalachians - their present and potential value. Popular journal.
Beal, J. A.	The control of the turpentine borer in the naval stores region. Department Bulletin.
Nelson R. M. and Beal, J. A.	Experiments with blue stain fungi in southern pines. Phytopathology.

Nelson, R. M. and Gravatt, G. F. — The tannin content of dead chestnut trees. Journal of Leather Chemists Association

Euell, J. H. — Our native shrubs. Address before Asheville Chapter of National Plant, Flower, and Fruit Guile, March, 1929. To be printed by the Guile.

Prelininary results of a study of cut-over areas in the Southern Appalachians. Journal of Forestry.